PhD in Information Technology and Electrical Engineering
Università degli Studi di Napoli Federico II

PhD Student:

Cycle: XXXVII

Training and Research Activities Report

Academic year: 2021-22 - PhD Year: Second

*__student signature_*

Riccardo Carbone

Valentina Casola

Tutor: prof. Valentina Casola

tutor signature

Co-Tutor:

Date: October 31, 2023

Training and Research Activities Report

PhD in Information Technology and Electrical Engineering

Cycle: **Author:**

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1. Information:

  ➢ **PhD student: Riccardo Carbone**   **PhD Cycle: XXXVII**

  ➢ **DR number: DR995859**

  ➢ **Date of birth: 21/06/1995**

  ➢ **Master Science degree: Computer Engineering   University: Università degli Studi di Napoli Federico II**

  ➢ **Scholarship type: no scholarship**

  ➢ **Tutor: Valentina Casola**

  ➢ **Co-tutor:**

2. Study and training activities:

Activity	Type[1]	Hours	Credits	Dates	Organizer	Certificate[2]
Publish Open Access with IEEE	**Seminar**	**1**	**0,2**	**9/11/2022**	**Eszter Lukàcs, IEEE Client Services Manager**	**Y**
Rails Final Event	**Seminar**	**4**	**0,8**	**30/05/2023**	**Dr. Zhiyuan Lin, RAILS Project**	**N**

  1)   Courses, Seminar, Doctoral School, Research, Tutorship
  2)   Choose: Y or N

2.1. Study and training activities - credits earned

	Courses	**Seminars**	**Research**	**Tutorship**	**Total**
Year 1	**13**	**5,2**	**35**	**0**	**53,2**
Bimonth 1	**0**	**0,2**	**6**	**0**	**6,2**
Bimonth 2	**0**	**0**	**6**	**0**	**6**
Bimonth 3	**0**	**0**	**6**	**0**	**6**
Bimonth 4	**0**	**0,8**	**6**	**0**	**6,8**
Bimonth 5	**0**	**0**	**6**	**0**	**6**
Bimonth 6	**0**	**0**	**6**	**0**	**6**
Total	**13**	**6,2**	**71**	**0**	**90,2**
Expected	**30 - 70**	**10 - 30**	**80 - 140**	**0 – 4.8**	

3. Research activity:

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During the second year, I continued my studies on agile software development models applied to the research and development of critical software. The focus on agile development in safety-critical fields is mainly motivated by the current state of the art, where there is an observable shift from the standard waterfall approach to flexible hybrid agile methodologies:

From a general point of view, the usage of hybrid agile development methods could help software companies to:
- *Manage changes in requirements;*
- *Reduce project costs and delivery time;*
- *Anticipate verification and validation activities.*

Nevertheless, in order to gain the above advantages, software organizations should develop a clear structure for the management of non-functional software requirements. Indeed, a poor management process for non-functional requirements could negatively impact the agility of software development teams.

Considering the Scrum 4 Safety development model that our research team defined in the first year, I decided to concentrate my research activities on the main challenge of integrating non-functional software requirements management practices. Thus, I started the two subsequent research activities.

Integration of safety-critical software testing and agile methodologies

The first activity I started this year analyzed the theme of safety-critical software testing. Indeed, this very time-consuming activity is one of the most difficult to integrate into an agile development model. However, the fundamental cause of this problem is neither related to the complexity of testing safety requirements nor the absence of supporting instruments for automation but from the semantic gap between testers and their instrumentation. In fact, there is an essential difference between safety-unrelated fields and safety-related ones in terms of the instrumentation learning curve for testers.

From a general point of view, in safety-unrelated fields, testers can count on various tools that support them with models to design, write, and evaluate their test plans very quickly. The JUnit 5 framework, for instance, supports testers with a simple, efficient, and extensible model that covers all the fundamental aspects of test case specification and execution.

Safety-related fields, in contrast, are characterized by the presence of expensive and proprietary tools that offer poor models for test case specifications.

In order to bridge this gap in the Rete Ferroviaria Italiana - Research and Development Department, I designed a translation tool that enabled testers to write test cases with the JUnit 5 model and then execute it with RFI-certified instrumentation. The choice of reusing the JUnit 5 model comes from its acceptance and diffusion in agile safety-unrelated fields.

Considering the validation of the solution, the principal research methodologies applied in this field are case studies, surveys, and appropriate quantitative/qualitative metrics. In particular, multiple case studies are needed to analyze the impact of our proposal on the tester's proficiency in different projects and domains. Nevertheless, the mix of quantitative/qualitative metrics gathered from a single case study with surveys would help our group reach more consistent and objective conclusions.

Documentation process of non-functional requirements

The second research activity regards the general life-cycle of non-functional requirements. In particular, to develop a comprehensive agile model for safety-critical software, one should establish a structured way to elicit, document, and trace non-functional requirements before the testing activity. During this year, I concentrated my focus on state-of-the-art practices to manage the life cycle of non-functional requirements.

Literature shows that agile teams have developed many methods and practices to elicit and document quality requirements, but very few general and consistent frameworks were proposed. Furthermore, it seems there is a lack of tools that can guide developers during the application of the suggested approaches.

4. **Research products:**

5. **Conferences and seminars attended**

6. **Periods abroad and/or in international research institutions**

7. **Tutorship**

8. **Plan for year three**

For the next year, I plan to complete my research activities.

Firstly, I plan to in-depth analyze the implications of using the JUnit 5 testing model to increase the proficiency of testers for safety-critical software. In order to achieve that, our research group will construct representative validation scenarios in collaboration with RFI for next year.

Secondly, I plan to construct a model for the specification and traceability of non-functional requirements that integrate with the classical workflow of agile developers. Considering the literature, it will be fundamental for the proposed model to be simple, easy to integrate, and supported by appropriate tools and metrics. In that way, I will add to our Scrum 4 Safety development model a much more consistent specification for applications in critical fields, where non-functional requirements are considered dominant over functional requirements.

Finally, the presented activities will include a period abroad in European research centers, which currently collaborate with RFI - R&D, in order to expand our analysis and results outside the RFI context.